Trends in United States Mass Fatality Incidents and Recommendations for Medical Examiners and Coroners

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ABSTRACT

It is imperative that medicolegal jurisdictions prepare for the occurrence of a mass fatality incident. Despite the trend to plan for catastrophic and complicated incidents, this analysis of recent mass fatality events seeks to better inform authorities regarding the scale and types of incidents that could potentially impact their jurisdiction. The guidance provided by this study serves as a tool to guide the development of plans, acquisition of appropriate resources, and training of staff.

To perform this analysis, data were collected from mass fatality incidents occurring in the United States from January 1, 2000 to December 31, 2016 that resulted in ten or more fatalities. Specific data points were collected for each incident including the date, location, number of fatalities, incident type (e.g., man-made or natural), incident subtype, and description (e.g., mass shooting, hurricane, aviation). A total of 137 incidents fit the criteria for inclusion in the analysis, resulting in a total of 8462 fatalities. The average number of incidents was eight per year during the study period. The analysis demonstrates that most mass fatality incidents (88.8%) result in between ten and 50 fatalities and are variable based on incident type and geographic location.

This study includes several large-scale incidents, which as outliers have influenced fatality management operations and preparedness efforts on a national level. In particular, the World Trade Center attack of September 11, 2001 and subsequent remains recovery and identification operations have served to inform the New York City Office of Chief Medical Examiner of the capabilities required to manage a complex, protracted victim identification process involving extensive body fragmentation and commingling. While the World Trade Center attack has been shown to be outside the normal trends of mass fatality incidents, it has nonetheless offered the medicolegal community several invaluable lessons. *Acad Forensic Pathol.* 2017 7(3): 318-329

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INTRODUCTION

It is imperative that medicolegal jurisdictions prepare to respond to a mass fatality incident. The failure to plan for a mass fatality incident will result in the inability to respond adequately and will permanently damage the trust of the public and the victims' families in the medical examiner/coroner (ME/C). Despite the perceived need to plan for catastrophic and complicated incidents (1), this analysis seeks to better inform authorities regarding the scale and types of incidents that could potentially impact their jurisdiction. While the average ME/C office may experience an overwhelming mass fatality incident at some point, the trends show that they are more likely to experience a smaller incident. Offices must be prepared to handle these incidents at a local level, not relying on state or federal assets to support fatality management operations. Federal funding and resources, such as Disaster Mortuary Operational Response Teams (DMORT), are generally tied to legislation such as the Aviation Disaster Family Assistance Act of 1996 (2) and the Rail Passenger Disaster Family Assistance Act of 2008 (3), requiring commercial carriers to have a plan in place or in such incidents that invoke the Stafford Act (4) requiring a presidential declaration to make funding available.

The capacity of small medicolegal jurisdictions to prepare for a mass fatality incident is limited and should focus on the types and scale of incidents the area is most likely to experience. The guidance provided by this study serves as a tool for the development of plans, acquisition of appropriate resources, and training of staff. In addition to the data gathered from these incidents through local and national experience, lessons have been learned regarding the successful management of mass fatality incidents. These lessons should be considered during a jurisdiction's planning process to support the development of a successful fatality management response system.

METHODS

In a search for the definition of a mass fatality incident the general wording one will find is:

... any incident resulting in more decedents to be recovered and examined than can be managed in the local medical examiner/coroner jurisdiction (5).

By this definition, the scale of qualifying incidents will vary by jurisdiction, based on the office's capabilities and ability to concurrently manage incident-related fatalities and day-to-day operations; therefore, each jurisdiction should determine what criteria will trigger their use of special operations to conduct fatality management operations. More specifically, the New York City Office of Chief Medical Examiner (NYC OCME) has developed an objective definition with specific criteria for a mass fatality incident, which includes: any event having the potential to yield ten or more fatalities; any situation in which there are remains contaminated by chemical, biological, radiological, nuclear, or explosive agents or materials; any incident or other special circumstance requiring a multi-agency response to support mass fatality management operations; and any incident involving a protracted or complex remains recovery operation (6). These criteria, while more defined, still depend on the discretion of agency leadership to activate any response elements and encourage assessment of the incident to continually augment the response stance.

For the nationwide retrospective study, data were gathered from various sources through a collaborative effort of personnel at the NYC OCME and the Harris County Institute of Forensic Sciences. Various data points were collected for each incident including: incident location (jurisdiction), incident date, number of fatalities, incident type, incident subtype, description, DMORT deployment status, and federal declaration status.

These data provide a valuable resource for understanding trends in mass fatality events in the US (7,8). For the present study, a subset of the data were compiled for all incidents utilizing the first criteria listed above, an event yielding ten or more fatalities, and the timeframe was limited to events that occurred from January 1, 2000 through December 31, 2016.

RESULTS

A total of 137 incidents fit the criteria for inclusion in the analysis, resulting in a total of 8462 fatalities. Classified by incident type, there were 56 natural incidents (40.8%), of which none were attributed to disease, and 81 man-made incidents (59.1%). The breakdown in the number of incidents per type or subtype is depicted in **Figure 1**. The most prevalent incidents were transportation-related incidents with 47 occurrences (34.3%), which includes motor vehicle accidents, airline incidents, rail incidents, boating accidents, etc. The next most common incidents were natural weather-related events, including tornados with 25 incidents (18.2%) and hurricanes with 13 (9.4%).

It should be noted, to maintain consistency, that this study focuses on the mechanism of the incident and does not take intent into consideration. The definition for “terrorism” has not been formally agreed upon for use as a definitive classification; in addition, criminal investigations can continue for years beyond the occurrence of the incident or be inconsistently pursued. Therefore, any incidents that may be attributed to “terrorism” or which are found to have a criminal element are grouped with those of similar mechanism. In addition, it was observed that several incidents resulted from a combination of multiple incident categories. These incidents were sorted into the primary, or initiating, category for this study. For example, the Christmas Eve massacre in Covina, California on December 24th, 2009 resulted in fatalities caused by primary gunfire with secondary arson; this incident was categorized in the mass shooting grouping. In addition, the events of September 11, 2001 were separated into three separate transportation incidents: the Pentagon attack, the downing of Flight 93, and the airline attacks at the World Trade Center (WTC) in New York City. Although typically discussed as a group, these incidents would each individually be considered separate mass fatality incidents, as they were managed by different jurisdictions. However, natural disasters that bridged multiple jurisdictions were treated as a single incident as the deaths can all be connected to a single source.

The average number of incidents across the United States was eight per year during the study period (**Figure 2**). Each year is additionally broken down to show the number of natural incidents and man-made incidents. The highest number of incidents was seen in 2003 at 13 and the lowest number was in 2014 at four; however, no obvious trends were observed over the course of the study period.

The analysis demonstrates that most incidents (88.8%) in the study period resulted in ten to 50 fatalities (**Figure 3**). A very small number of incidents (2.1%) resulted in over 300 fatalities. The average number of fatalities per incident was 62; however, there are two large-scale incidents that stand out from much of the data and impact the resulting analysis: the WTC attacks (2001), resulting in 2753 fatalities; and Hurricane Katrina (2005), resulting in 1833 fatalities. Both of these events resulted in federal declarations and involved the assistance of DMORT. Removing these outliers from the data presents a more common picture for the scale of mass fatality incidents that will be experienced by most ME/C jurisdictions. Without these incidents, the average number of fatalities per mass fatality incident decreases from 62 to 29.

As outlined in **Table 1**, the incident category that occurred most frequently over the study period was transportation incidents, with 47 incidents, of which aviation incidents accounted for 24 and motor vehicle accidents accounted for 12. Of the natural events, tornados resulted in 25 mass fatality incidents and hurricanes resulted in 13. The least frequently occurring incidents were asphyxiation and stampede, both occurring only once.

The incident category that caused the most fatalities per incident during the study period was hurricanes, resulting in an average 54 fatalities (excluding Hurricane Katrina). The incident category that caused the least number of average fatalities per incident was motor vehicle accidents, resulting in an average 11 fatalities, likely limited due to the passenger capacity of vehicles. It should be restated that this analysis only considered incidents in which the fatality count was ten or greater. Furthermore, some of the incident cat-

Figure 1: Classification of mass fatality incidents by type and subtypes, including the relative number of incidents for each occurring from 2000-2016.

Figure 2: The number of mass fatality incidents each year from 2000–2016 differentiated by natural and man-made incidents.

egories (e.g., asphyxiation and stampede) have very small sample sizes and, as such, the average number of deaths per incident type in these cases may not be indicative of a wider trend.

Geography has been shown to be a key factor, particularly for weather-related mass fatality incidents. Over the study period, coastal storms are most likely to impact the southeast and gulf coastlines, with fewer storms causing fatalities in the northeast. Tornado-related fatalities occur most prevalently in the midwest and southeast regions, with few or none occurring in the other regions of the United States. These trends are not unexpected as it is common knowledge that different regions of the country experience different weather patterns. Location is less predictive when applied to man-made mass fatality incidents. These types of incidents are distributed more generally across the US. Instead of utilizing past trends in man-made incidents, it is important for ME/C to work alongside

the local or state emergency management agency to conduct hazard analysis and understand the specific vulnerabilities present in their respective region.

Federal declaration does not guarantee that the impacted jurisdiction will receive funding to specifically support fatality management operations. Thirty-nine of the 137 incidents (28.4%) in this study resulted in a major disaster declaration by the sitting President under the Stafford Act (4); of these declarations, 35 were natural incidents (89.7%) and four were man-made (10.2%). However, the breakdown of this funding is variable and determining whether any of such funding was specifically designated to fatality management is beyond the scope of this article. Twenty-four of the 137 mass fatality incidents (17.5%) involved commercial carrier transportation incidents covered under federal air and rail assistance legislation. Disaster Mortuary Operational Response Teams, or representatives, deployed to 17 incidents (12.4%), which quali-

Figure 3: Mass fatality incidents from 2000–2016 by number of fatalities.

fied for inclusion in this study. Of those deployments, nine of the 17 received federal major disaster declarations and ten were legislated airline incidents (**Table 2**). Three incidents received both designations. Only one incident received a DMORT deployment with neither of those distinctions: the Station Club Night Club Fire, which occurred in West Warwick, Rhode Island in 2003.

Medical examiner/coroner offices in the US are typically underfunded and understaffed for daily operations, let alone incidents involving mass or complex fatality management operations (9). However, the low percentage of incidents that have triggered potential funding sources, personnel, or resources indicates that ME/C must be prepared to manage such incidents at the local level. Preparedness efforts include developing

plans, fostering interagency relationships, acquiring appropriate equipment and supplies, and conducting trainings for personnel. The incidents included in this study, large and small, provide a brief snapshot of the incidents that could impact a jurisdiction and provide the medicolegal community with invaluable lessons.

DISCUSSION

Recommendations

No matter the size, scope, or location, there are several general lessons that can be gleaned from the mass fatality incidents over the past two decades. Most importantly, the failure to prepare for the probability of an “all fatal” incident will result in a complete failure in one’s jurisdiction’s emergency response plan. Tra-

Table 1: Categorization of Mass Fatality Incidents by Type and Category From 2000-2016

MFI Type	Category	Incidents		Total Deaths		Average Deaths	
Natural	Wildfire		3		41		14
	Flood		8		174		22
	Hurricane	Minus Katrina	13	12	2480	647	191
	Mudslide		3		69		23
	Tornado		25		997		40
	Winter Storm		4		89		22
Man-made	Aviation	Minus WTC	24	23	3663	910	153
	Bus/Motorcoach		6		80		13
	Collapse		3		40		13
	Explosion		7		106		15
	Fire		10		252		25
	Marine		3		42		14
	Motor Vehicle		12		133		11
	Stampede		1		21		21
	Rail		2		36		18
	Asphyxiation		1		19		19
	Mass Shootings		12		220		18

Average Number of Fatalities Per Incident = 62

Average Number of Fatalities Per Incident (excluding WTC and Hurricane Katrina) = 29

MFI - Mass fatality incident

WTC - World Trade Center

ditional emergency response planning and preparedness focuses heavily on preservation and protection of life, property, and infrastructure. Response efforts are concentrated on search, rescue, and treatment of casualties. But what happens when there is no one to save? Planning efforts must include strategies for the recovery, processing, transport, and identification of decedents, and must include policies for aiding and sharing information with families. While law enforcement, fire departments, and emergency medical services regularly respond to emergency situations and mass casualty incidents; ME/C personnel do not respond to mass fatality incidents with any frequency. This requires jurisdictions to utilize fatality management plans, training, and exercises to prepare personnel for the inevitable. Jurisdictions must also identify other agencies that can support and augment fatality management operations. For example, in New York City, several agencies including the Department of Sanitation (DSNY) and Department of Transportation (DOT) are leveraged to support logistics and fleet needs following a mass fatality incident.

The medicolegal authority should initially be on-scene and in communication with the incident command element to gain situational awareness, assess the extent of fatality management operations, determine resource needs, and identify next steps. The immediate involvement of the medicolegal authority ensures that the integrity of the scene is optimally preserved for identification of the decedents. Victim identification begins at the first interaction between responders and the decedent on-scene. Medicolegal authorities must take jurisdiction over fatality management operations to preserve the integrity of the remains and evidentiary materials (especially identification information) on-scene for use in the examination and identification process. This requires that responding agencies leave the decedents and associated evidence *in situ* to be documented and processed appropriately. The evidence will be packaged with the associated remains and thoroughly documented in the morgue. Considerations can also be made for multiple agencies to perform joint scene evaluations. Joint processing of the scene ensures that each agency's priorities are met

Table 1: Categorization of Mass Fatality Incidents by Type and Category From 2000–2016

Incident Name	Year	Fatalities	Federal Declaration?	Legislated Air/ Rail Incident?
Alaskan Airlines Flight 261 Crash	2000	88		X
Executive Air Aviation Accident	2000	19		X
World Trade Center Attack	2001	2753	X	X
Flight 93 Attack	2001	44	X	X
Pentagon Attack	2001	189	X	X
Flight 587 Accident	2001	265		X
US Airways 5481 Aviation Accident	2003	21		X
Station Club Night Club Fire	2003	100		
Hurricane Ivan	2004	57	X	
British Aerospace Aviation Accident	2004	13		X
Hurricane Katrina	2005	1833	X	
Hurricane Rita	2005	120	X	
Comair Flight 5191 Aviation Accident	2006	49		X
Hurricane Gustav	2008	53	X	
Hurricane Ike	2008	113	X	
Continental Flight 3407 Aviation Accident	2009	50		X
Joplin Tornado	2011	161	X	

and provides an opportunity for agencies on-scene to identify their respective priorities.

While mass casualty incidents may be resolved relatively quickly, mass fatality incidents have the potential for long, protracted recovery and identification operations. The condition of the remains (e.g., fragmented and burned) and the characteristics of the scene (e.g., compromised infrastructure, flooding, heavy debris) may result in complex operations. The most prominent example of this is the recovery and identification process for the victims at the WTC site of the September 11 terrorist attacks. Due to the violent nature of the incident, from initial impact to structural collapse, the debris field was unprecedented and remains were highly fragmented and otherwise damaged. Initial recovery efforts lasted for eight months. Unexpected discoveries in 2006 triggered renewed search and recovery efforts at the WTC site (10-13) that continued sporadically until 2013. Even today, 16 years after the incident, the NYC OCME continues DNA work to identify all 2753 known victims. The inability to identify all victims will be a key factor in the length of any operation.

Following a mass fatality incident, timely and accurate identification of decedents will be of utmost priorities. The challenges associated with victim identification will be driven by the availability of antemortem records and by the preservation of the body. Compared to a closed population incident in which all victims involved are known (e.g., a commercial airline crash), open population incidents present additional challenges since the actual number of victims is initially unknown. A jurisdiction must have a method in place prior to an open population incident to allow law enforcement to efficiently investigate missing persons reports and develop a vetted missing person list. The complexity of this process and potential impact to the identification process cannot be underestimated.

It is important to consider forensic identification modalities such as fingerprint or dental comparisons that can be completed quickly prior to reliance on DNA testing. Despite advances in technology, DNA remains the most expensive, complex, and lengthy identifica-

tion modality. For incidents involving significant body fragmentation, there will be a greater reliance on DNA testing for identification of victims, resolution of comingling, and reassociation of fragmentary remains to specific individuals (10, 14-16). Research has also shown that the length of time associated with victim identification is correlated with condition of the bodies and the type of identification modality employed (14). The September 11 WTC attacks resulted in 2753 known victims. To date, there have been 21 905 human remains recovered (17), which indicates the degree of fragmentation and complexity of the identification efforts. As other identification modalities were unavailable in most cases, approximately 90% of all WTC victim identifications have involved DNA. To date, there are still 1113 (41%) known victims who remain unidentified (17).

Following a mass fatality incident, there could potentially be large amounts of data based on the circumstances of the incident and the conditions of the remains. Managing a complex, data intensive identification process requires computer applications and systems to be in place to collect and manage large amounts of data from various sources. These systems must be established, tested, and trained on prior to the occurrence of a mass fatality incident to ensure success. Specifically, the medicolegal authority must have a system to document, manage, and reconcile all the identification information that will be collected during the postmortem examination process and interview process. More broadly, systems must consider inter-agency data needs and operational dependencies related to missing persons investigations, patient tracking, victim reunification, and fatality management.

While the goal of any fatality management operation is to achieve 100% accuracy, the reality is that humans are involved in every step of the process, which introduces the potential for errors. Areas of possible points of failure in the information collection process include inaccurate data from informants, misunderstandings between informants and interviewers, uneven training for interviewers, information incorrectly recorded by interviewers, lack of standardization, handwritten interviews, etc. (18). Establishing training programs

for personnel, utilizing standardized protocols, using direct data entry into computer databases, and maintaining open communication with families can help minimize some of these risks. In addition, establishing quality control measures provides added protection against potential errors. Some examples include an exit review and an identification review committee. During an exit review, a reconciliation of postmortem examination files is completed to confirm accuracy and completeness. The formation of a multidisciplinary identification review committee serves as the ultimate opportunity for forensic personnel with various areas of expertise to confirm the victim identification against any doubt or inexplicable discrepancy.

Ultimately, the way in which the interactions with family members are managed will define the overall success or failure of the response to the incident. It is the duty of the medicolegal authority to serve the families of the decedents with factual, timely information in a compassionate manner. It is critical to manage the expectations of families, but also to manage the expectations of the other groups involved in the process: the public, elected officials, and response personnel. Adopting sound forensic standards to effectively and efficiently identify the decedents of a mass fatality event, while providing some level of transparency to the process, will help prevent second-guessing and speculation from all affected parties.

CONCLUSION

Despite the data presented in this study, ME/C are often encouraged to plan for catastrophic level incidents, instead of the smaller, more manageable incidents that have occurred. Medicolegal authorities must be prepared to manage these smaller incidents on their own at a local level. Federal and private assistance is expensive and are reserved for incidents that trigger federal funding sources, such as legislated transportation incidents or those that garner a federal declaration.

The inability or unwillingness to conduct mass fatality management operations concurrent with life safety operations indicates a lack of appreciation for fatality management and the identification process. In to-

day's world, which revolves around a 24-hour news cycle and social media coverage, it will be publicly unacceptable to delay fatality recovery following an incident. It is imperative for the medicolegal authority to assert their jurisdiction and communicate fatality management priorities to the incident command element. Families will not wait to receive information; they will start to demand it. Respect for the dead and providing answers to families enables resiliency. The work of caring for the dead is, in fact, done to support the living.

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